California Energy Commission

STAFF REPORT

FINAL EVALUATION REPORT

2008 Building Energy Efficiency Standards

Proposed Compliance Option for an Alternative to the use of Temperature Measurement Access Holes

CALIFORNIA
ENERGY COMMISSION

Edmund G. Brown Jr., Governor

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ABSTRACT

California's *Building Energy Efficiency Standards* require that ducted split system central air conditioners and ducted split system heat pumps have the correct refrigerant charge verified (Section 151(f) 7Ai and ii). Proper refrigerant charge is necessary for compressor air-conditioning systems to operate at full capacity and efficiency. This requirement applies to new and altered space-cooling equipment installed in new or existing homes.

The standards specify that the correct refrigerant charge can be verified through measurement or through the installation of a Charge Indicator Display. A Charge Indicator Display must be installed by the cooling system installing contractor and allows visual monitoring of the system's performance. When a Charge Indicator Display is not installed a Home Energy Rating System Rater must verify that split system air conditioners and heat pumps have the correct refrigerant charge using procedures specified in the *Reference Appendices for the 2008 Building Energy Efficiency Standards for Residential and Nonresidential Buildings* (CEC-400-2008-004-CMF, Revised June 2009). This is accomplished by methods specified in the Standard Charge Measurement Procedure of Section RA3.2 of the reference appendices. A method used in this procedure in which the system's correct refrigerant charge is to be calculated is for checking airflow temperatures across the evaporator coil by drilling of Temperature Measurement Access Holes for the placement of temperature sensors. Section RA3.2.2.2.2 of the reference appendices specifies the location and hole diameter size that must be drilled and labeled in the supply and return plenums in order for this measurement and verification procedure to be valid.

Field evidence indicates that for some installations temperature measurement access holes cannot be drilled into equipment as specified due to physical constraints where the equipment is placed within the building. This compliance option would allow an alternative to meeting the temperature measurement access hole requirements provided specific conditions are met.

Keywords: California Energy Commission, ducted split system central air conditioners, ducted split system heat pumps, refrigerant charge, reference appendices, *Building Energy Efficiency Standards*

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Background

Many air conditioners in California fail to achieve their rated efficiency and to provide cooled air efficiently due to improper amounts of refrigerant, improper removal of moisture and air from refrigerant lines, metering device malfunctions, and other related problems. The statewide energy needed to drive air conditioners strongly affects peak demand and utility electricity prices. To reduce air conditioner energy consumption and peak demand, the *Building Energy Efficiency Standards* require specific procedures for installers to use and for third-party Home Energy Rating System (HERS) Raters for verifying the correct refrigerant charge and proper air conditioner system operation in residential buildings. These field verification methods were developed from stakeholder input using manufacturers' specifications and verification protocols. Refrigerant charge measurement and verification procedures are specified in Section RA 3.2 of the *Reference Appendices for the 2008 Building Energy Efficiency Standards for Residential and Nonresidential Buildings* (CEC-400-2008-004-CMF, Revised June 2009).

"Refrigerant charge" refers to the amount of liquid refrigerant present in the system. Excessive refrigerant charge (overcharge) reduces system efficiency and can lead to premature compressor failure. Insufficient refrigerant charge (undercharge) also reduces system efficiency and can cause compressors to overheat.

Methods to improve the operation of home air conditioners were first implemented with the *2001 Standards.* Improvements have been made over the years that reflect changes in industry practice and to respond to observations from the field. The *2008 Standards* require that the refrigerant charge for ducted split system central air conditioners and ducted split system heat pumps is verified through one of two measurement methods or by installing a charge indicator display. "Split system" refers to an air conditioner or heat pump that has physically separate condenser and air handling units that work together as a single cooling system. Refrigerant charge verification methods are through:

- Use of temperature measurement access holes (TMAH) for placement of temperature sensor probes in the equipment's supply air plenum/coil box and the return air plenum/blower compartment[1]
- Saturation temperature measurement sensors (STMS) and proper refrigerant charge confirmed by a HERS Rater[1]
- A charge indicator display (CID) that is visible by the resident[2]

1 Use of procedures described in 2008 Reference Appendices, Section RA3.2.

2 Use of procedures described in 2008 Reference Appendices, Section RA3.4, and JA6.

Compliance Option

Public Resources Code Section 25402.1 (b) requires the California Energy Commission to establish a process for certification of compliance options of new products, materials, and calculation methods that can improve building efficiency levels set by the *Building Energy Efficiency Standards.* Section 10-109 of the standards allows for the introduction of new compliance approaches that cannot be properly accounted for in the current approved compliance approaches.

The Energy Commission encourages the use of energy-saving techniques and designs to show compliance with the standards that are approved by the Energy Commission through the compliances option approval process. Compliance options can be generally viewed as:

- Affecting a change in compliance by changing the scope of the requirements.
- Affecting a change in compliance by enhancing the current compliance process.

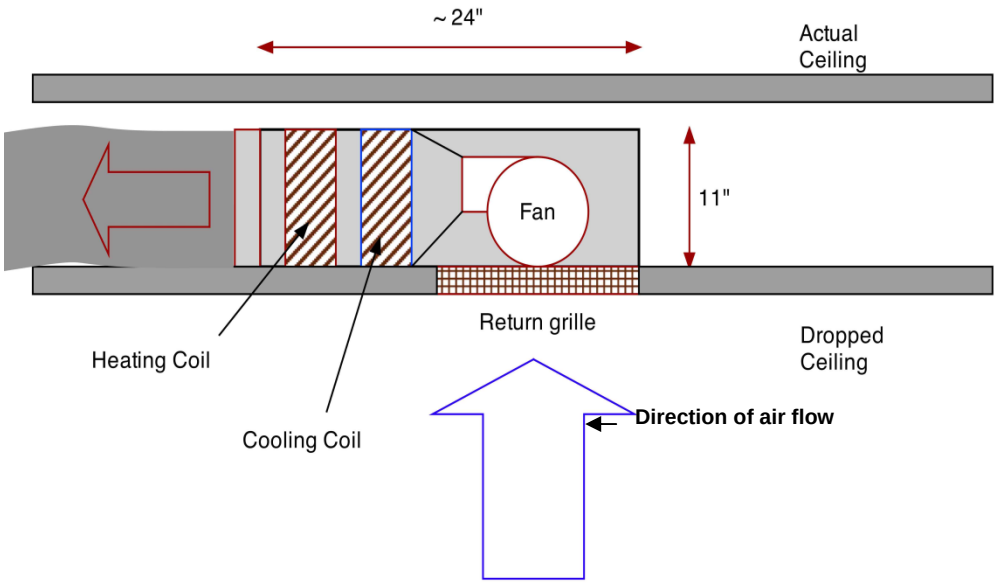
Staff Evaluation

When a CID is not installed a HERS Rater must verify that split system air conditioners and heat pumps have the correct refrigerant charge using methods specified in the Standard Charge Measurement Procedure of Section RA3.2 of the reference appendices. The standard charge procedure applies to HERS Raters, not installers, and is to be used when the outdoor air temperature is 55^0F or above. A method used in this procedure in which the system's correct refrigerant charge is to be calculated is for checking airflow temperatures across the evaporator coil by drilling of temperature measurement access holes for the placement of temperature sensors. Section RA3.2.2.2.2 of the reference appendices specifies the location and hole diameter size that must be drilled and labeled in the supply and return plenums in order for this measurement and verification procedure to be valid.

The HERS Rater uses these access holes for estimating the minimum required airflow for determining the correct refrigerant charge by inserting temperature sensors into the supply and return side plenum, and measures the temperature difference between the supply and return sides of the air coil.

Information provided to the Energy Commission by HERS Raters indicates that the variability in building designs, particularly in multifamily housing, often results in restricted space allowed for installing space-conditioning equipment. Insufficient space inhibits proper drilling of required TMAH in the supply and return plenums; or in some HVAC system designs there is no plenum into which holes can be drilled. In one specific example, 200 air-conditioning systems, known as "pancake units" (see Figure 1) were installed in a 12-inch dropped ceiling space. The lack of a return air plenum prohibited the installer from drilling TMAH and the HERS Rater from measuring air flow using the TMAH method.

Figure 1: Typical "Pancake Unit"



Source: Sierra Building Science

The Energy Commission's newly adopted *2013 Building Energy Efficiency Standards* recognizes this building design situation, and revisions have been made to the refrigerant charge requirements to address such a circumstance. The *2013 Standards* include further refinements on the residential refrigerant charge installation and verification procedures, including an "exception" from meeting TMAH if access holes cannot conform to specifications described in Section RA3.2 of the reference appendices.

Proposed Compliance Option

Staff proposes to allow this same "alternative" procedure from meeting the TMAH requirements for use with the current *2008 Standards* for residential buildings. This compliance option would allow an alternative to meeting the TMAH requirements, provided specific conditions are met. (See Table 1)

Public Review

On November 15, 2012, a public webinar was held by Energy Commission staff to present the proposal for an alternative to meeting the TMAH requirements. Staff's presentation and the discussion from the approximate 4 participants focused primarily on the needs in the marketplace to allow equipment installers and HERS Raters the ability to meet the intent of refrigerant charge without having to use the TMAH verification procedure when it cannot be

realistically met because of design and installation constraints. Staff has not received public opposition to establishing the proposed alternative to meeting the TMAH requirements, or any opposition to the proposed eligibility conditions.

Conclusion

Success of the standards depends on proper installation and operation of measures required by the compliance procedures and listed on compliance documents. Local building departments help ensure all measures are properly installed and that field verification procedures are adhered to. Properly operating space-cooling systems assure home comfort and that estimated energy use and annual savings are achieved. This staff-proposed allowance for an alternate procedure for field installation and third-party HERS verification of ducted split system central air conditioners and ducted split system heat pumps recognizes building design constraints in the market, and allows equipment installers and HERS Raters to better meet the intent of the standards.

Table 1: Requirements for Determining Refrigerant Charge

Residential Air Conditioning Measures

Improved Refrigerant Charge		
Purpose	Component packages require in some climate zones that split system air conditioners and heat pumps be diagnostically tested in the field to verify that the system has the correct refrigerant charge. For the performance method, the proposed design is modeled with less efficiency if diagnostic testing and field verification are not performed. The system must also meet the prerequisite minimum cooling coil airflow requirement.	2008 Reference Residential Appendix RA3.2
Requirement	When required for compliance by *2008 Building Energy Efficiency Standards*, Section 151(f)7A , a 5/8 inch (16 mm) diameter hole shall be provided as shown in 2013 Reference Appendices Figure RA3.2-1. • Return plenum temperature measurements shall be taken at the location specified in Figure RA3.2-1 when performing the procedures in RA3.2. The measurement access shall be sealed to prevent leakage after the measurements have been completed. • The access hole location shown in Figure RA3.2-1 can be applied to any one of the four sides of the return plenum. The access hole location shall be labeled "Title 24 – Return Plenum Measurement Access" in at least 12-point type. • For air-handling units with the return located entirely within conditioned space (such as when an up-flow air handler is mounted on a pedestal in a closet in the dwelling, or when the return grille is an integral part of the air-handling unit), the return plenum measurement access hole is not required, and in this case the return air temperature measurements shall be taken at the return grill when performing the procedures in RA3.2.	
Alternative	Systems that cannot conform to the specifications for the access hole location shown in Figure RA3.2-1 shall not be required to have holes as described in Figure RA3.2-1 provided the eligibility criteria listed below are met: • An alternate location is used that provides access for making an accurate return plenum measurement, or • An alternate procedure is used meeting the criterion listed below: 1. The installing contractor shall upload to the HERS Provider's Data Registry an explanation as to why the TMAH cannot be installed and photographs of the equipment for which the TMAH cannot be installed; and 2. The HERS Rater shall verify that the installation of the TMAH on the HVAC system is not possible in accordance with RA3.2.2; and 3. The HERS Rater shall verify proper airflow by using a flow capture hood, a flow grid, or through plenum pressure matching.	

Source: California Energy Commission